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Use Cases of BIM

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Irina Maltseva

Abstract

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Abstract

The purpose of the research was to compare all previous lists and update the classifier according to new data published on the official website of BuildingSMART. Since the BIM use case documents have insreased and have different criteria, our task was to understand how many BIM use cases are there and whether all these documents are determined by this classification, what is the difference, and what is new. The document demonstrates the relation of standards and how they interact. Also, according to the given data, BIM use cases are replenished every year.

BIM is one of the tools used in this generation that helps many construction companies and builders improve the quality of their work and simplify file exchange between different countries.The use case management of BIM has 122 documents. 101 use cases are available in database. Any use case contains a clear objective and focuses on a specific outcome or benefit. Also, the database includes 2 technical reports, 2 bSI awards, 12 standards/guidelines, 1 Information Delivery Manual and 4 case studies.

The BuildingSMART standard covers a wide range of process and information capabilities unique to the built environment industry, including: an industry-specific data model schema - Industry Foundation Classes [IFC], Information Delivery Specification [IDS], Model-based, software-independent communication protocols - BIM Collaboration Format [BCF].

Keywords

Use cases, Standards, IFC, IDS, BCF, API, IDM, BIM, UCM, ISO29481

Contents

1 Introduction

Building Information Modelling, or BIM for short, is a technique that enables networked planning, execution, and management of buildings. It creates a digital representation, i.e. a 3D model containing information about the physical and functional characteristics of the building. The information is collected centrally in one place and is thus available to all participants. The building data model, with all the information it contains, provides a solid basis for decision making throughout the life cycle of a building, from concept to dismantling.

Using this way of working brings numerous benefits to all stakeholders from different sectors such as construction and real estate or facility management. One of the main advantages of the BIM method is the centralized data management since all information can be accessed from one place. This makes structured and efficient work possible (Adapted from DiConneX).

BIM should not be seen as a standalone tool, but as part of a complex web of similarities and workflows with other tools in the design ecosystem. The model can be developed in several ways depending on what is desired and most efficient. Effective project implementation requires the use of a range of tools and workflows.

There are 122 documents in use case management of BIM, here we will collect all types of use cases and categorize them through a review of published documents, the main source of which is the international use of CAS Service Buildingsmart. Collect data through ARChival research, access articles, chapters, reports, papers and publications about use cases and Buildingsmart standards.

The purpose of the research was to compare all previous lists and update the classifier according to new data published on the official website of BuildingSMART. Since the BIM use case documents have doubled and have different criteria, our task was to understand how many BIM use cases are there and whether all these documents are determined by this classification, what is the difference, and what is new.

2 What is BIM?

BIM technology is the process of collaborating on a BIM model. An opportunity is being created for joint design, the purpose of which is to obtain economic and energy-saving effects in the development of construction master plans and construction schedules. Depending on the stage of work, its level of detail changes. BIM is not only a 3D model, but also a lot of additional information that goes beyond the geometric model. Parametric modelling differs significantly from conventional 2D drafting or 3D modelling. Parametric links implement the interaction between individual elements of the information model. The BIM model contains regulatory documents, numerical characteristics, tables, specifications, schedules, etc.

BIM is an important tool in architecture, design and construction. BIM software creates a digital representation of the functional and physical characteristics of an object that can be used in information exchange. But it is also a process of capturing all structured information, coordinating different systems and platforms, maintaining and sharing knowledge in a standardized and digitized form. This process is where the classification determines the language and structuring of information in a BIM perspective.

Classification is a meaningful way of describing the division of them into varieties according to some important features. Building classification systems have established standard terminology and semantics for the building sector that can be used in a variety of ways. It helps to summarize and organize existing knowledge in a structured way. In the construction industry, the use of classification systems is critical in dealing with specifications, structuring documents, calculating costs, communicating information, and more. More importantly, in the BIM paradigm, the standard classification of building element models is one of the main steps in organizing product models. Product models can be ordered to estimate the cost of a building model or obtain design information by providing a classification code. Also product models can be sorted in product databases.

With the development of information modelling technology, architects and contractors often require an organized collection of product models for various purposes such as cost estimation. In addition, tthroughout the life cycle of a building, there is an increasing need to share product modelling information with product suppliers and project partners, both nationally and internationally. This highlights that organizing such information in a systematic way is critical to better understanding and use of the data.

3 Use case management of BIM

BuildingSMART Use Case Management is specialized for skill sharing between professionals from current or existing BIM/VDC plans. The best practice is formed based on personal practical skill. The use cases are not tied to individual steps of the plan, but provide for the entire chain of creation, consisting of planning, construction, then operation, and then – deconstruction.

Each use case has clear goals that focus on a specific outcome or benefit. Applications from various stakeholders are in the planning stage. It focuses on who needs the information, when, in what form, and at what level of detail to make a specific decision.

BuildingSMART's international application variation management service makes it possible to collect, discover and distribute best practices, as well as to give them to the entire branch of building assets for future use.

Throughout the design, construction and operation process, communications requests must be addressed for any BIM application. Based on the BuildingSMART Information Delivery Manual (IDM) methodology, it outlines operational processes and, as a result, requests for information exchange. A clear definition of the stream of information between the proper members of the plan ensures common work and effective and accurate replacement of data.

3.1 Standards of use cases of BIM

Building Smart enables global consensus among stakeholders in specific areas to accelerate adoption and deployment. The BuildingSMART standard covers a range of technology and information capabilities specific to the built environment industry, including (Adapted from buildingsmart.org):

- Industry Foundation Classes [IFC] - An industry-specific data model schema
- Information Delivery Specification [IDS].
- BIM Collaboration Format [BCF] - Model-based, software-independent communication protocols

3.2 IFC

Despite the fact that the IFC format was registered by the International Organization for Standardization (ISO) back in 2005 and accepted as an official norm, it often continues to be used by design companies only for internal needs. Such use does not meet the main

reasons and goals of the creation of the format and does not reflect the main tasks that IFC solves.

The main purpose of accessing IFC files is control: the format allows you to control the flow of information, terms of work and money. Control is maximally simplified thanks to the structure and experience incorporated into it by international developers. The buildingSMART consortium encourages its renewal and development precisely as a tool for controlling capital costs for each facility.

The second most important function of IFC is the creation of an independent customizable CAD environment at a facility that has brought together many contractors. Contractors can use various CAD systems, CAD-independent environments, their own ERP systems in their work, which data is generated in numerous non-interoperable formats. And for effective communication and control over costs, deadlines and information, a unified format is needed.

The next advantage of IFC is the exchange of experience. The data warehouse and its structure is the very quintessence of user experience. For example, the format and the basic requirements for the class will draw the attention of the user installing the door to the properties of this door, to the properties of the technological map of its installation, to the fact that different participants with different roles and responsibilities will be involved in the installation process. Referring to IFC classes will give the user access to international experience contained in ISO standards, without having to refer to the original source of standards. Thus, IFC is an already assembled full-fledged product for working with a project, which allows you to predict the life cycle of an object of one nature or another.

The key is the use of IFC as a tool for fixing copyrights and liability. The transfer of information from one performer to another includes only the data that is required in the next stage, while the data of the previous stage remains with the direct developers. This feature may not be of great importance in the design of a cottage, a small shopping center or a hotel, but is critical in large international sites. BuildingSMART is an international consortium that brought together major international developers and it was on their basis that the IFC format was born.

The main areas of application of the IFC format are large regional and complex international projects, considering this, the attitude to the format itself, some possible errors associated with import or export, and details related to setting up tables within CAD systems are changing. A complex and large-scale international project involving many contractors (for example, an airport in Kuwait or the Pontsteiger project in Amsterdam) requires building a complex data exchange structure and fine-tuning information flows. In this case, it is IFC that

will serve as a tool for integrating systems with each other and for effective exchange of information and control over time and costs.

IFC is approached in projects with state participation. Proprietary formats are subject to copyright modifications and are not available to those who have not purchased a license, and therefore cannot be used by government agencies for the purpose of data exchange. In projects with state participation, we inevitably turn to open formats, this is also true for passing the examination of the model.

IFC is used in the management of capital construction projects because it is a text format compatible with any ERP-enterprise resource planning system. This process can also be scaled to public administration or management of information about capital construction projects: issuing building permits, building processes related to the management of capital construction projects, etc. Such examples are known today: one of the advanced countries here is Finland, where the entire capital, Helsinki, and several nearby cities, are managed based on geographic information systems and systems built based on IFC. All government activities related to capital construction projects are based on them, which means that the state customer will not need to purchase software, technical support from vendors will not be required, and at this moment there will be no lobbying for any product.

3.3 IDS

IDS (Information Delivery Specification) is a document that defines the information/data exchange requirements within the framework of information exchange based on a BIM model. The IDS document is written in such a way that it can be read by a machine. The IDS document defines how BIM model objects, classifications, properties and values or units of measure are to be delivered and exchanged (Adapted from BibLus).

An Information Delivery Specification (IDS) can be very helpful in properly defining Information Requirement Levels (LOINs) in Employer Information Requirements (EIRs) and BIM Execution Plans (BEPs).

The new IDS standard from buildingSMART is a solution to one of the most important aspects of customizing a building information model project: the models fit the purpose for which there is a request from clients.

IDS was created to meet the need to define and optimize the management of dynamic and complex information requirements.

The characteristics of the information to be exchanged during the life cycle of a building asset are contained in standards that provide guidance for information specification needs

and are applicable to any stage of the life cycle of a building asset, including (Adapted from BibLus):

- strategic planning;
- initial design;
- engineering;
- development;
- documentation and construction;
- daily work;
- maintenance;
- repair;
- restoration;
- end of life (EOL).

Adoption of the IDS standards gives you access to services and software solutions designed to manage the creation, refinement, and validation of information expected in information specifications and BEPs. All stakeholders involved in the process can work quickly and reliably using standardized and well-defined data structures. The exact process is shown in figure 1 and described on the table 1.

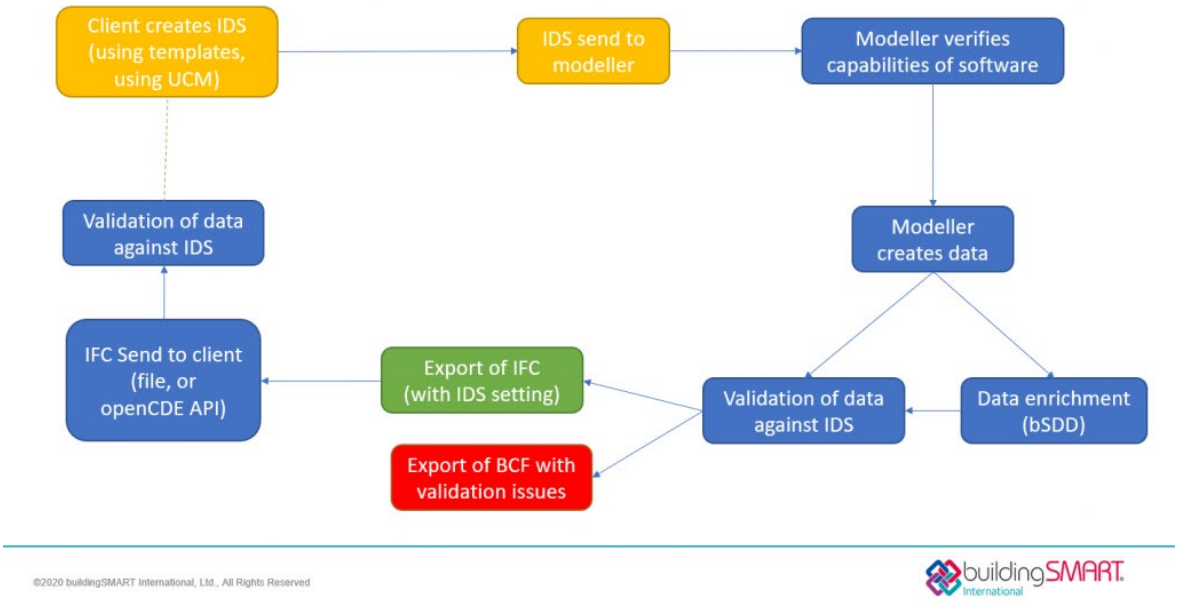

Figure 1. IDS process (buildingsmart.org).

Table 1. IDS Process

Stakeholders	Steps of process description
Client	Create your own message specifications in a way that operators and software solutions can understand; Enrich your requests for the exchange of all useful information to make it easier to understand your requests; Results will be provided that may already be related to the IFC model.
Modeller	Automatic creation of information structures based on order specifications that are properly linked to the IFC model; Navigate data entry and avoid table or relational errors.
Validator	Immediate feedback on the quality of results is achieved through the ability to automatically compare requirements requested in the assigned IDS with requirements received in the delivery IDS. The entire supply chain can refer to a standardized template and focus on the content of the project without worrying about understanding the form and quality of expected results.

3.4 BCF API

BCF is a file format for exchanging remarks/comments on a project that allows you to add appropriate screenshots to the comments.

The quality of IFC data exchange can be improved by using the BIM Collaboration Format (BCF). BCF is an open format officially approved by buildingSMART and used in many

structural and engineering design applications and model checking programs. This format allows you to add screenshots, camera positions, and 3D section planes to an IFC model. With it, you can create thematic comments for individual elements of the model. This allows other users to easily find related IFC model elements (Adapted from buildingsmart.org).

A Web Service and API is an XML-based information exchange system that provides direct interaction between a client and a server. Such a system may include programs, objects, messages, or documents.

What is the difference between a web service and an API? A web service is a set of open-source protocols and standards that are used to exchange data between different systems and applications. An API is a programming interface that allows two applications to communicate with each other without user intervention. All web services are APIs, but not all APIs are web services.

3.5 IDM and MVD in ISO 29481

BIM adds value to banking, construction management. To use this method, the necessary information must be available at all stages of the construction period. It describes the company's needs in an ideal scenario, including goals, success criteria, communication, and early communication activities. Agreements, contracts, standards. This sale will affect the results of the communication process. This standard is described in: ISO 29481 Building Information Models - Guidance for information delivery. Part 1: Methodology and format defines the structure and methods for presenting process maps and exchange requirements for a specific purpose. he standard provides a framework for the exchange of information between users. The main requirement is that there must be conditions for the data to be accurate and sufficient for practice.

IDM helps you reap all the benefits of BIM. If BIM contains the necessary information to support the construction process or use, and the quality of the information is satisfactory, then the process itself will be improved.
IDM allows supply chain stakeholders to define their information needs by identifying use cases, mapping processes, and defining exchange requirements. It also requires a review of the processes involved in the design development life cycle of the entire built environment, including the information needed to complete the process and the information gained from its implementation. This applies to any activity arising from, for example, the exchange of information, which may not be directly related to BIM. The process by which design work or contractual agreements are achieved (Adapted from ISO 29481).

This part of ISO 29481 specifies a methodology for providing an integrated reference document that describes the process and information needed to create or manage a created entity. It explains how to define and describe the process, the data to be processed, and the results. This part of ISO 29481 provides a framework for secure exchange or exchange of information by users. The development of this part of ISO 29481 was driven by user requirements for exchange. reliable information. Therefore, IDM standards are a general way of deriving exchange requirements for specific use cases. IDM is the best way to move your business. An IDM is also a technical document (physical or digital) that describes business requirements, operational and transactional, and recommunication requirements for a specific purpose. Businesses need to define use cases. IDM is a powerful way to create and share use cases.

IDM consists of three core elements (Figure 2) elements (Adapted from buildingsmart.org).

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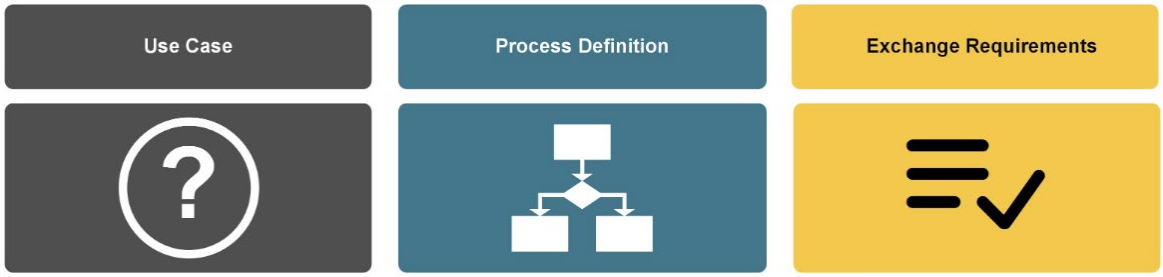

Figure 2. Core elements of IDM elements (Adapted from buildingsmart.org).

• Use Case- defines propose and the scope for the information delivery.

• Process Definition is made through at least one of the following: Process map / Interaction map / Transaction map.

• Exchange Requirement- Information delivery exchange requirements in non-technical format.

A diagram showing the various components of IDM and how they relate to each other is provided. IDM has two concepts. This is considered important for both the user and the technical solution. In all these concepts, there are several regions that are

characteristic of different parts of the IDM (Figure 3).

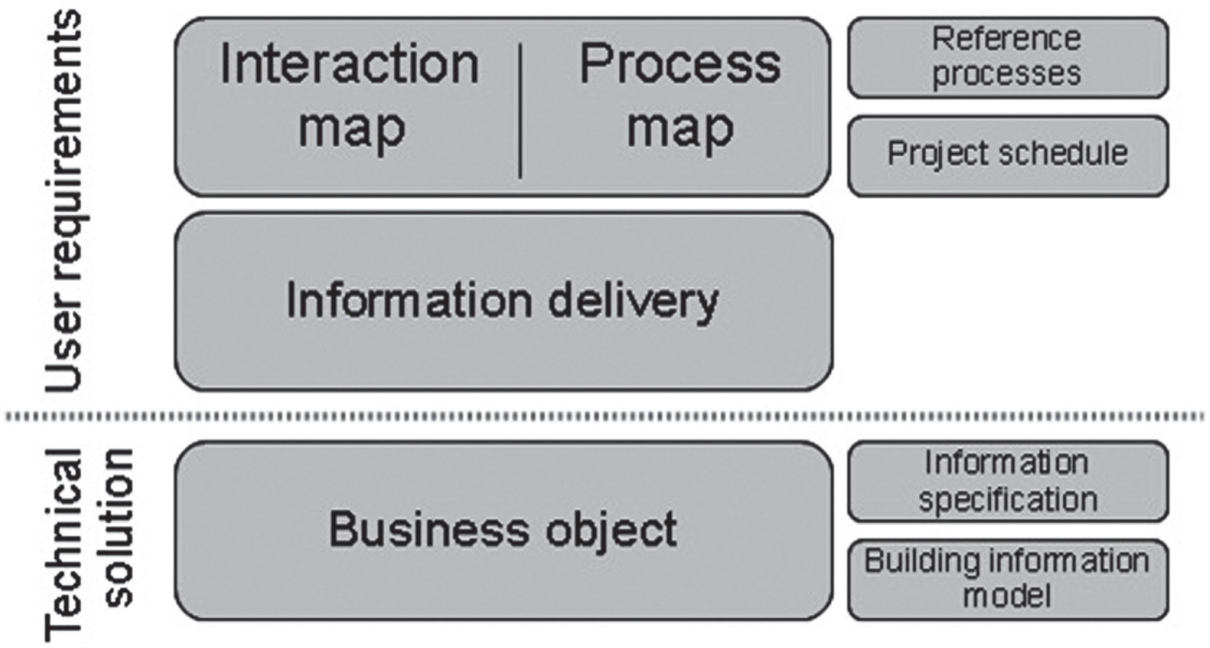

Figure 3. IDM zones (ISO 29481).

Within the user-requirements perspective, these zones are (Adapted from ISO 29481):

— interaction maps, describing the roles and interactions between them,

— process maps, describing the overall process in which information exchange occurs,

— information delivery, describing the information exchange needs,

— reference processes (stored exchange descriptions),

— the project schedule (occurrences of processes in the context of a project).

The technical-solution perspective includes

— the business objects comprising the exchange requirement model,

— the information specification, describing the schema on which the information exchange is based,

— the building information model.

3.6 MVD

Model View Definition-is subset in the overall IFC schema to describe data exchange in specific tasks workflow (Adapted from ISO 29481). MVD can be quite wide range, such as almost the entire scheme (for example, for archiving of the project), and narrow

specialization - as a pair of object types with an associated information (for example, to determine the cost of a hinged facade system). MVD instructions provide repetitive exchange types, providing consistency and predictability of results for various projects and software platforms. For example, an architect sends a simple model to a client for placement inside a large urban model, giving the client the opportunity to visually evaluate project, the architect does not need to send all the data geometric construction of the model and attributes of objects, and a simple geometric model from surfaces with a simple coloring by color or overlaid textures. Second example: At the same time, the architect can send the IFC to the contractor a file that only contains information about infills window openings, their identifiers, and characteristics energy efficiency, as the software application contractor does not display geometry, but generates reports for cost estimates and specifications for purchases. In both examples, the architect does not need to delete any data before sending the file. The architect only needs to indicate what data must be downloaded from its software tool client, for their intended use in software client tool.

The next development step is to create a technical specification in the form of a Model View Definition (MVD). MVD is a subset of IFC schemes that satisfy one or more specific exchange requirements. It defines a valid, consistent, and complete subset of the IFC schema, and contains guidelines or rules for implementing the IFC concepts used (ISO 29481).

MVD forms the basis of the software development process that provides IFC import and export capabilities in software applications. This coordinated process allows the software application in use to share the relevant data for processing.

3.7 Relation between IDM and MVD

An MVD defines a data model, or subset of an existing data model, required to support one or more. Specific data exchange requirements (Fig. 4). MVD is used in software development and a machine-readable representation. Information can be filtered using a single IDM-only MVD from software tools to specific exchange requirements. When information constraints are added to MVD combinations can be used for data validation purposes. Software products supporting multiple exchanges a requirement may be to implement a unified MVD that references multiple IDMs. These MVDs are often used. However, data validation should always be performed on individual MVDs (ISO 29481).

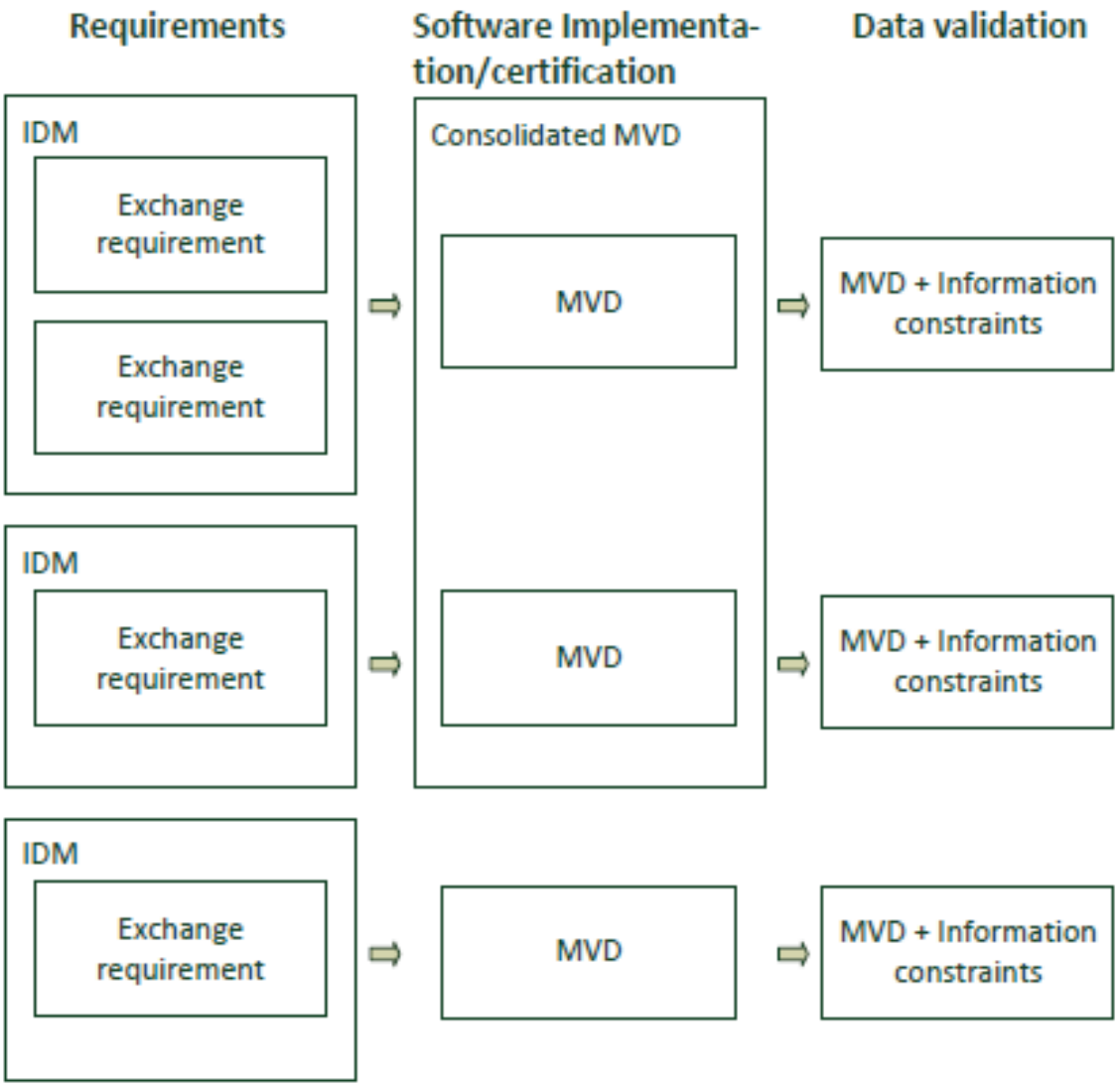

Figure 4. Relation between IDM and MVD (ISO 29481).

3.8 Relation between IDS and MVD

While MVDs and IDSs are related concepts within the BIM framework, they serve different purposes:

— MVDs focus on defining the content and structure of a BIM model for specific use cases or disciplines.

— IDSs focus on specifying the information requirements and deliverables throughout the project lifecycle.

However, it's worth noting that MVDs can be a component of an IDS. In other words, an IDS may include multiple MVDs to define the required model views and information exchanges at different stages of a project.

Overall, MVDs and IDSs play complementary roles in BIM implementation, contributing to improved collaboration, coordination, and information management within construction projects.

Today, Model View Definitions (MVDs) play a critical role in ensuring interoperability and consistent data exchange within Building Information Modeling (BIM). MVDs define specific requirements for different types and subsets of the BIM model, enabling effective collaboration and information exchange between project stakeholders.

However, one can speculate on possible reasons why MVDs may become less necessary in the future:

— Standardization and improved interoperability: As BIM adoption continues to grow, industry standards and improved interoperability between software applications may emerge. As software tools and platforms become more standardized and interoperable, the need to define custom MVDs for specific purposes may decrease.

— Advanced artificial intelligence and machine learning. With advances in artificial intelligence and machine learning, algorithms can better automatically extract the necessary information from BIM models. This can potentially reduce the need to manually define and share specific model representations as intelligent systems can parse and extract the required information when needed.

— Modeling semantic data. Semantic data modeling is concerned with determining the meaning and relationships of data elements. If BIM models include more semantic data structures and richer metadata, this can increase the flexibility and adaptability of the models. This can reduce reliance on predefined MVDs and allow stakeholders to dynamically get the information they need based on their specific needs.

— Development of collaboration platforms. Future collaboration platforms may offer advanced tools and features to enable seamless data sharing and collaboration across disciplines and stakeholders. These platforms can potentially automate the extraction and rendering of specific views or subsets of a BIM model, eliminating the need for explicit MVDs.

It is important to note that these assumptions are based on possible future events and trends. However, the acceptability and effectiveness of such advances may vary, and MVDs may continue to play a valuable role in BIM adoption for the foreseeable future.

4 Building Information Modelling use case documentation

4.1 The history of the creation of the document BIM use cases

4.1.1 First BIM use case classification file.

The first multi-page Excel file made it possible to provide data on various BIM use cases which was created on 3 June 2018 (Fig.2). The file only provides a list with a description for further development with a more detailed description of each use case. The use cases described by BuildingSMART International are an attempt to determine how people take advantage of BIM when using and repurposing information within a project and group of projects. Each use case is divided into one phase, which in the future will be an integral part of the logo buildingSmart: Design, Procure, Assemble, Operate. This award documentation form has chosen the simplified approach defined by BuildingSMART International for classifying use cases. This is not necessarily directly related to the categories of awards, however, the connection certainly exists.

Every year use cases change, different countries push forward and develop new use cases, which consist of several stages of development. Several use cases are the same, but described in different languages, at different stages and differ only in project status. Only 50 use cases are presented in the document, which will increase in number in the future.

ISO 12006-2	bSI IDM	2017 Phases	HOAI (Germany)	RIBA (UK)	CSI / CSC OmniClass (Canada / USA)		Phase List Used	Simplified bSI Phases	Award Category
Inception / Procurement	Portfolio Requirements	Requirements	Programming	Strategic Definition	31-10 00 00	Inception Phase		Design	Design
Feasibility	Conception of Need	Need							
Outline Proposals, Programme Preparation	Outline Feasibility	Feasibility		Preparation & Brief	31-20 00 00	Conceptualization Phase			
	Substantive Feasibility			Concept Design					
Scheme Detail / Costing	Outline Conceptual Design	Concept	Planning for Preliminary Design	Developed Design	31-30 00 00	Criteria Definition Phase			
	Full Conceptual Design		Planning for Conceptual Design	Technical Design	31-40 00 00	Design Phase			
Detail design / costing	Coordinated Design and procurement	Coordination	Planning for Submission and Permission		31-50 00 00	Coordination Phase		Procure	Construction
Production information and Bills of Materials	Production Information	Production	Planning for the Execution Documents						
Tender Action			Prepare Tendering						
Construction Preparation	Construction	Construction	Contract Agreement	Construction	31-60 00 00	Implementation Phase		Assemble	
Construction operations on-site			Construction Supervision - Assembly						
Completion				Handover & Closeout	31-70 00 00	Handover Phase			
	Operations & Maintenance	O&M	Handover & Documentation	In Use	31-80 00 00	Operations Phase		Operate	Operate
Feedback	Disposal				31-90 00 00	Closure Phase			
									Student

Figure 5. Table of classification (Adapted from dksic.com).

4.1.2 Second BIM use case classification file

The second document, which goes into more detail for each use case, includes much more pages, columns, and criteria. Now all of the phases included in the buildingSmart International logo and the distribution of 50 use cases between the phases (Figure 6). The

document was created on May 18, 2020. Another author has added significantly more information that differs from the first document. The names and phases of use cases have not changed, but criteria such as maturity, notes, original definitions, Fundamental LOD definitions, legend have been added. Also, the use case strategy table has been improved.

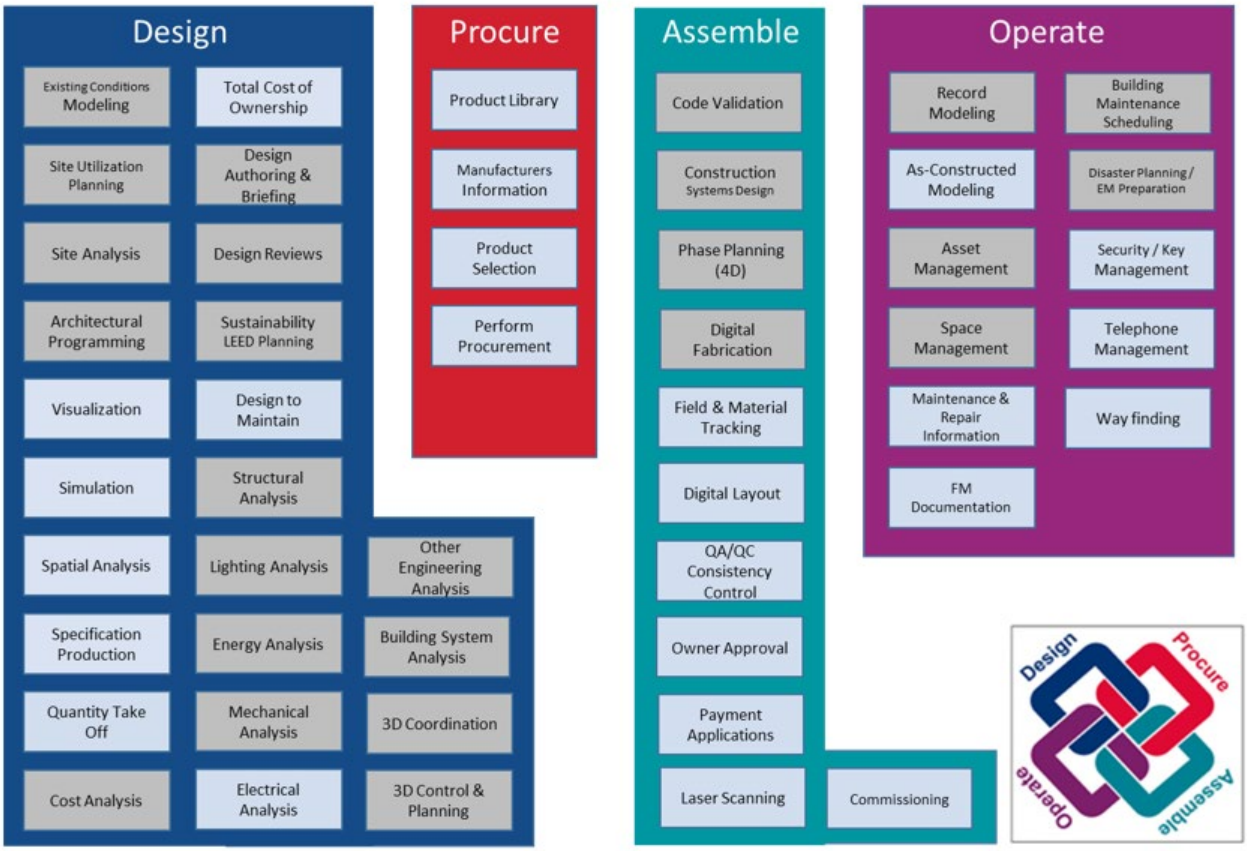

Figure 6. New Classification diagram (Adapted from dksic.com).

If we compare the similar criteria of the second document and the third document, which was developed during the research of this thesis, then the general criterion is maturity. Figure 7 shows the distribution of use cases according to the numbers, where the distribution goes according to the scores highlighted in different colours (Figure 6). The range is calculated from 4-9, having 3 colour palettes: red, yellow, and green. In accordance with the colour is distributed evaluation. If you filter out all the use cases in the latest document that were taken from the official source of buildingSmart, then the estimates go into the following stages: example, Outlook, proven, approved.

	Use	Title	Maturity
DESIGN	1	Existing Conditions Modeling (ECM)	8
	2	Site Utilization Planning (SUP)	7
	3	Site Analysis (SAN)	6
	4	Architectural Programming (ARP)	8
	5	Visualization (VIZ)	9
	6	Simulation (SIM)	8
	7	Spatial analysis (SPA)	8
	8	Specification production (SPR)	6
	9	Quantity Take Off (QTO)	8
	10	Cost analysis / Estimation (CAE)	7
	11	Total Cost of Ownership (TCO)	4
	12	Design Authoring and Briefing (DAB)	8
	13	Design Reviews (DER)	8
	14	Sustainability Evaluation (SEV)	4
	15	Design to Maintain Analysis (D2M)	7
	16	Structural Analysis (STR)	8
	17	Lighting Analysis (LTA)	7
	18	Energy Analysis (ENA)	7
	19	Mechanical Analysis (MEA)	7
	20	Electrical Analysis (ELA)	6
	21	Other Egineering Analysis (OEA)	6
	22	Building System Analysis (BSA)	4
	23	3D Coordination (3DC)	9
	24	3D Control and Planning (3DP)	6

Figure 7. Classification of maturity level (Adapted from dksic.com).

4.1.3 Third BIM use case classification

Today, there are more documents published in BuildingSMART. Previous list doesn't exist anymore. Total of 103 versions of documents of use case management written in Dutch, English, French, German. The peculiarity is that there are completely new criteria with which we can qualify all documents and distinguish them according to the following criteria: document type, GUID, identifier, life cycle stage, revision, project status, maturity level, use case, processes, ER, publisher.

There are several document types. Most of them are use cases, but there are also 4 cases study, 2 technical reports and 9 standards/guidelines. Some use cases are approved, a few are in progress, others are drafts. The N/A stage is added to the process and ER column.

Among the publishers there are companies from different countries, which were not in the first and second documents. If we consider the life cycle stage, many use cases were associated with ISO 22263. As for the study option, out of 4 proposed documents, only one

was confirmed, the rest was presented as a draft. Most of the standards/guidelines are also in draft stage, but 2 of them are in proposal and approved stage.

If we consider the project status of the entire list, then the following criteria can be distinguished in total: draft, WIP (work in progress), approved, draft, example, proposal, uder review. There are 36 drafts in this list, 11 works in progress, 50 approved, 1 example, 2 proposals and 2 under review.

As for the level of maturity, there are several stages: example, outlook, proven, approved. Among them are 48 examples, 25 outlook, 13 proven, 1 approved and the rest have no information.

The stage of use of use has only 3 stages: approved, draft, in progress. 48 documents are approved, 19 drafts, 20 in progress, the remaining documents have no information.

In the EP criteria, 4 distributions are distinguished, which are similar to the final classification: approved, draft, in progress, N/A. 35 documents approved, 12 drafts, 36 in progress, 4 in N/A stage.

If we consider publishers, then new companies that were not considered earlier are added to this criterion. Such as: BIM Speed, Genossenschaft Migros Ostschweiz, VDI - Verein Deutscher Ingenieure e.V., SBB and official companies from several companies buildingSMART.

A new classification of BIM use cases in Excel is presented in Appendix 1.

4.1.4 New BIM use case classification

The use case management of BIM has 122 documents nowadays. 101 use cases are available in database. Also, the database includes 2 technical reports, 2 bSI awards, 12 standards/guidelines, 1 Information Delivery Manual and 4 case studies.

Within six months, 2 new categories of documents appeared: bSI award and Information Delivery Manual. Also, the number of use cases increased by 19 documents. Each use case was divided into one phase. It is an integral part of the BuildingSmart logo: Design, Procure, Assemble, Operate. The phases were included earlier and subdivided into 4 categories, the logo has not changed, but new phases have been added to the BIM use cases.

BIM use cases can be classified into the following categories nowadays (buildingsmart.org):

- Design and Visualization: BIM can be used to create a 3D building model that can be used to visualize the building design and identify potential issues before

construction begins. BIM can also be used to create detailed drawings and specifications that can be used by contractors during the construction phase.

- Coordination and Collaboration: BIM can be used to coordinate the work of various contractors and professionals, as well as to improve collaboration between architects, engineers, contractors and owners. BIM can help avoid collisions or conflicts between different systems such as electrical and plumbing systems before they happen. This can help reduce delays and rework during the construction process.
- Construction Management: BIM can be used to manage the construction process including logistics, safety, and quality control. BIM can be used to create a construction schedule and track progress against the schedule. BIM can also be used to manage the construction site, including logistics, safety, and quality control.
- Procurement and Delivery: BIM can be used to manage the procurement and delivery of materials and equipment, track their status and delivery to site. BIM can help ensure timely delivery of materials and equipment to the job site and manage inventory of materials and equipment on site.
- Performance Analysis: BIM can be used to measure the performance of the building, to simulate energy consumption and lighting, and to optimize the design of the building in terms of energy efficiency and sustainability. BIM can also be used to assess the building's structural performance, such as wind and seismic loads, and to optimize the design of the building in terms of safety and durability.
- Maintenance and Operations: BIM can be used to manage the operations and maintenance of the building, including scheduling maintenance tasks and tracking their completion, as well as managing the building's assets such as B. Equipment and furniture. BIM can also be used to monitor building performance, such as energy consumption and maintenance needs, and to optimize building operations for efficiency and sustainability.
- Cost Estimation and Planning: BIM can be used to estimate construction costs and plan the construction process, including scheduling and resource allocation. BIM can also be used to track costs during the construction process and to manage the project budget.

Overall, BIM technology can be used throughout the construction process to improve collaboration, reduce errors and rework, and optimize building performance. BIM can help ensure construction projects are completed on time, on budget and to the required quality standards. BIM can also help improve communication between stakeholders, including

architects, engineers, contractors and owners, enabling a more transparent and efficient construction process. As a result, BIM is gaining popularity in the construction industry and is expected to become standard practice in the near future.

5 CONCLUSION

Digital transformation has brought many new opportunities, but it has also brought new challenges to the industry. The construction industry needs a global organization dedicated to creating and developing common open data standards. BuildingSMART meets this need.

Open global standards for digital data exchange are critical to helping businesses, designers, engineers, contractors, and operators become global industry leaders by reducing risk, saving time, reducing costs and dramatically increasing productivity.

The growing use of BIM also allows owners and operators to plan their capital investments with their service partners and understand the potential costs of maintaining and using these assets for their intended purpose throughout their life cycle.

Accordingly, all standards are interconnected. Considering the buildingSmart standards, one can single out the main functions of the standards: interaction in the business process environment, information transfer, transformation of processes into technical requirements and interaction between BIM applications.

Also, according to the given data, BIM use cases are replenished every year. This conclusion can be drawn based on the history of the classification of BIM use cases. Previously, only 50 options were presented, now this number is 122. The official website of buildingSmart presents not only use cases, but also technical reports, case studies, standards or guidelines, bSI awards, IDM that can be classified into several categories.

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Appendix 1. New classification of BIM use case management in Excel.

	Select from list(Original name of the document)	Select from list (Name of the document in English)	Description	Document Ty	GUID	Identifier	Life Cycle Stage	Revision	Project Stat	Maturity level	Use Case	Processes	ER	Publisher
1	BIM4FM (Grundlagen)	BIM4FM (basics)	The higher-level BIM4FM processes, which were developed by Bauen digital Schweiz/buildingSMART Switzerland, serve as an overview of the activities and responsibilities in the respective project phases for FM-compliant construction planning and implementation in the context of the BIM method. Accompanying the planning, clear specifications and requirements on the part of the customer are presented in a phase-appropriate and software-independent manner, which enables a smooth and efficient implementation of the tasks and handover of the developed results. The processes show the client what information he needs to provide and what information requirements he needs to formulate at an early stage so that an efficient project flow can be implemented. This gives the contractor the opportunity to generate good data quality. The necessary output is shown as the result of the respective sub-steps, which is also the prerequisite for the next steps. These documents and decisions are necessary and serve as a	Use Case	98100FB3-EC4E-4AA2-86DC-BE0F151C747F	-	SIA 112	Publikation V1.0	Approved	Proven	Approved	Approved	Approved	buildingSMART Switzerland
2	Creation of thermal 3D model	Creation of thermal 3D model	Methodology for creation of a 3D thermal model	Use Case	4999D5E-7EAE-413F-BF97-68A91C8	BIMSpeed_UC12_ASP	ISO 22263	-	Approved	Proven	Approved	Approved	Approved	BIM Speed
3	Retro BIM	Retro BIM	Creation of a digital twin of existing objects (as-built model of the construction incl. technical installations), which is geometrically verified and contains no redundant information and data per element. Output: 3D model of the existing infrastructure incl. information on the respective components Structured information possible to be exported and further processed via standardized interfaces Input: Available information of all kinds (Input I) Exploration information (project and client specific, Input II)	Use Case	45ECD0BD-68F1-40FC-A690-2D460DCC0227	-	RIBA - plan of work	1	Draft	Example	Draft	In Progress	In Progress	buildingSMART Switzerland
4	Routinemässige Reinigung	Routine cleaning	Cleaning of ordinary surfaces in a building daily or periodically more than once a year (daily, weekly, monthly, quarterly, biannual, etc.). Cost of periodic cleaning of a building, its facades and workplaces, emptying of rubbish bins.	Use Case	F994D432-CA1D-4061-AC33-840FECB2AF97	-	SIA 112	Publikation V1.0	Approved	Example	Approved	In Progress	Draft	buildingSMART Switzerland
5	Kollisionsprüfung (Freihalteräume)	Collision Check (Free Spaces)	Additional "virtual" elements are inserted into the model so that, among other things, spatial and geometric tolerances can be simulated. In this way, a space requirement for e.g. assembly, insulation and maintenance work can be simulated or restricted zones can be taken into account. The tests are part of the regular ongoing planning coordination and testing and can be carried out and assessed across any number of building systems and trades.	Use Case	A8381C07-EE41-4FF4-8EC8-4B58B1AF5572	-	SIA 112	Approved	Example	Approved	Approved	Approved	Approved	buildingSMART Switzerland
6	Regelbasierte Prüfungen (soft clashes)	Rule-based tests (soft clashes)	Rule-based tests arise from e.g. They are part of the regular, continuous planning coordination and review and can be carried out and assessed across any number of building systems and trades. Additional "virtual" elements are inserted into the model so that, among other things, spatial and geometric tolerances can be simulated. In this way, a space requirement for assembly, insulation	Use Case	DC2CFDD1-2922-4658-AEF5-10827F8928AF	-	SIA 112	-	Approved	Proven	Approved	Draft	In Progress	buildingSMART Switzerland